Restoration genetics in Murray Mallee and Neotropical Forests: implications for management and planning

2012 NCCARF PhD student Collaborative Travel Grant report

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Major Findings: During my visit to Europe, my analytical skills, future research projects and manuscripts were developed, based on my experiences at Uppsala University with meetings with academics from Sweden and Italy. Due to schedule changes of the Italy academic (Prof Giovanni Vendramin), this meeting took place in Sweden. *The outcomes of this travel have direct application to Australian revegetation practices where climate change is of great concern*.

Despite being crucial to understanding the impact of contemporary landscape change and developing genetic resource management strategies, too few studies have documented combined fitness and mating system changes as a result of habitat disturbance. I developed a novel analytical framework, documented in three studies, that would not have been possible without collaborating with academics from Sweden and Italy as well as my undertaking the previous trips to Europe in 2011 and to Costa Rica in 2010, also supported by *NCCARF*.

Firstly, in a meta-analysis, I found that habitat fragmentation was generally disrupting the mating patterns of woody plants (Breed MF, Ottewell KM, Gardner MG, Marklund MHK, Dormontt ED, Lowe AJ (in review) The generation gap: genetic resilience of tree populations to fragmentation is not extended to open-pollinated progeny. Heredity). In this same study, I show that the mobility of pollinators can potentially buffer/expose species to these effects: small-insect pollinated species (i.e. mobility restricted) were more susceptible to these mating pattern changes than bird pollinated species (i.e. not mobility restricted).

These two lines of evidence are crucial foundations to then study the fitness consequences of these mating pattern changes. I have provided two case studies on this topic from the southern Australian mallee to further explore these findings: one on the bird-pollinated *Eucalyptus incrassata* (Breed MF, Ottewell KM, Gardner MG, Marklund MHK, Stead MG, Harris JCB, Lowe AJ (in press) Mating system and early viability resistance to habitat fragmentation in a bird-pollinated eucalypt. Heredity); and one of the insect-pollinated *E. socialis* (Breed MF, Marklund MHK, Ottewell KM, Gardner MG, Harris JCB, Lowe AJ (in press) Pollen diversity matters: revealing the neglected effect of pollen diversity on fitness in fragmented landscapes. Mol. Ecol). These two case studies, together with the meta analysis, complement ideas proposed in our previous study on big-leaf mahogany populations across Central America (Breed MF, Gardner MG, Ottewell K, Navarro C, Lowe A (2012) Shifts in reproductive assurance strategies and inbreeding costs associated with habitat fragmentation in Central American mahogany Ecol. Lett., 15, 444-452).

I have prepared a complementary application of this knowledge in a review of seed-sourcing recommendations (Breed MF, Stead MG, Ottewell KM, Gardner MG, Lowe AJ (in press) Which provenance and where? Seed sourcing strategies for revegetation in a changing environment. Conserv. Genet). I found that accounting for evolutionary processes in revegetation projects will likely improve their long-term resilience, even in the face of great uncertainty. This review was conducted with helpful discussions with academics from Sweden and Italy as well as ideas discussed at the Genetic Translocations NCCARF workshop in Melbourne 2011.

Outcomes of collaboration: Outcomes of my visit to Sweden include improved statistical, laboratory and analytical skills which were used in each of the aforementioned manuscripts. These skills will be crucial for completing my PhD thesis. Looking beyond my PhD, future collaborative options were explored during my travels with both Australian and EU-based project options being discussed.

In particular, a joint project was developed with the University of Adelaide (Prof Andrew Lowe, Prof Barry Brook, Prof Corey Bradshaw, Dr Damien Fordham, Dr Steve Delean and myself), Uppsala

University (Prof Jon Ågren, Prof Martin Lascoux) and Italian National Research Council (Prof Giovanni Vendramin). Laboratory expertise partners (Michele Morgante - Institude of Applied Genomics, Italy), field locations (Mt Lofty and Flinders Rangers, SA) and potential study species (e.g. *Callitris gracilis*; *Eucalyptus leucoxylon*) were identified. A proposal is being drafted for an ARC Discovery Project submission in 2013.

All the analytical and manuscript developments achieved form part of my PhD thesis. These skills and training were not possible in Australia, and NCCARF's financial support of my travel is greatly appreciated.

Significance to adapting and protecting Australia's terrestrial biodiversity: Genetic diversity and mating system are important considerations for revegetation for biodiversity. These factors govern the adaptive potential of future generations of plants and therefore the long-term success of revegetation projects. If climate change-resilient communities are to be created in place of cleared land, then how and when these genetic factors come into play, the strength of their impact and how they impact seed quality, need thorough investigation. Good data supporting these issues will help demonstrate how and where to collect appropriate seed to maximise biodiversity benefits. There are various general seed-sourcing strategies that are likely appropriate to create resilient communities, but I stress that evolutionary biology, the life history of the species and environmental uncertainty are key determinants that affect which strategy is most suitable. With financial support of *NCCARF* enabling me to hold discussions with the academics visited during my recent travel, as well as support from the Native Vegetation Council of South Australia and my PhD supervisors and co-authors, I are beginning to provide evidence that will help overcome some of these issues and provide guidelines for important key Australian species used in revegetation.